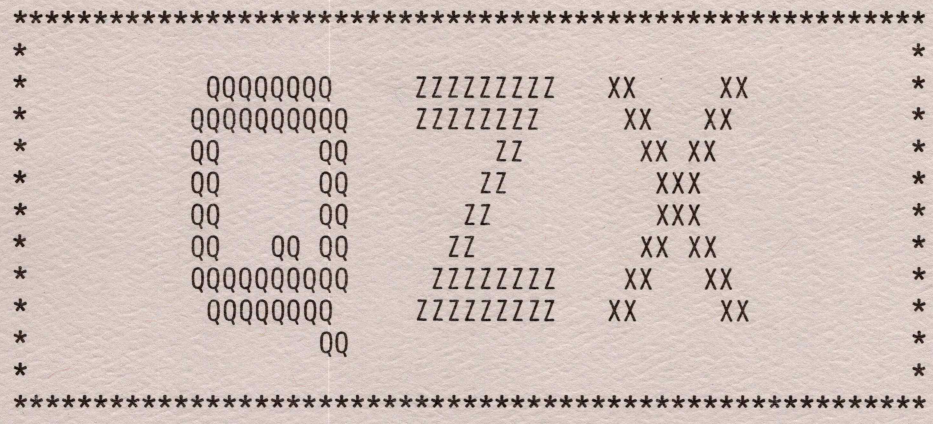
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The Journal Covering Amateur Radio & Sinclair Computers
ZX-80; Micro-Ace; ZX81; T/S 1000, 1500, & 2068; QL
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K5XY
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W4GHV
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Editor

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The American QL - A Peek Inside

Fred Nachbaur
(from Quantum Levels Magazine)

Most ZX81 hardware articles start with, "Remove the five screws...." Getting at the guts of the QL is somewhat more involved than this, so here is an article that fully details how to completely tear down your QL, and then put it all back together. Future articles may then assume that you know how to dismantle and successfully re-assemble your machine. Along the way, we'll point out the major components and various other landmarks.

Why would you even want to tear into your brand new QL? I'm usually one to admonish, "if it works, don't fix it". However, there are significant advantages to becoming familiar with the actual hardware of your computer. Once you've seen what's inside, it is no longer as mysterious and forbidding, so you will be more comfortable with the system as a whole. You'll see how it's all put together, so you'll have a better idea of its mechanical strengths and limitations. Lastly, you'll have less phobias about installing internal upgrades and improvements as they are developed.

More immediately, there are two simple modifications that you can make to the American QL to improve it significantly. The first, insuring against any possibility of crashes due to faulty regulator bypassing, is covered later in this article. (This one won't even require any soldering.) The second, covered in another article, details how to use your machine with an NTSC (American standard) composite colour monitor (including sound, if available on your particular monitor).

Although the QL is very definitely a "quantum leap' beyond the previous Sinclairs, it is still, unmistakably, a SINCLAIR machine. Specific similarities with previous ZXes will be pointed out as we go along. More generally, however, the QL shares the same philosophy of open hardware architecture that characterized the earlier Sinclairs. All CPU lines are available at the user ports, and all major chips (except RAM) are socketed. Compare with the Atari 520ST, in which the WRITE line is not available from the outside, preventing any RAM expansions. Not only that, but the CPU is soldered in! Boo, hiss! (I refuse to work with a machine that I can't get at. I recently got a good deal on a TI99/4A, but gave it away when I found that getting at the main circuit board was a major operation.)

The QL can be completely disassembled with simple hand tools. There are no rivets, welds or long solder beads to prevent access to any part of the machine. There are no weird screws requiring special drivers, lock-tabs that break off the first time you open them, or anything like that. This is not to say that things aren't tight inside that sleek black box. I'm sure that more than one engineer had sleepless nights trying to cram all that stuff in. In some places, clearances are literally zero. So exercise care and patience when working with the QL. These qualities, coupled with a modicum of mechanical skill, will be all it takes to make QL "hardware hacking" easy and enjoyable.

The bare-minimum collection of tools you will need are:

1: A good #1 Phillips screwdriver
2: A pair of needle-nose pliers
3: A fine-tip, 25W soldering iron
4: A roll of good rosin-core, 60% tin solder.

Other useful tools include a wire-stripper, a "soldering aid" to hold down hot wires, a multimeter (any type), methanol or isopropanol and Q-tips (how appropriate!) for cleaning, and a wrist grounding-strap (just to be sure about static). "Solderwick" and a "Soldapult" or similar suction-type solder remover can come in handy. More sophisticated tools like wire-wrappers will only be needed if you delve into "roll-your-own" hardware projects.

QL CONSTRUCTION

Like the previous ZXes, the QL consists basically of two case-halves made of an ABS plastic. The case-halves are held together from the bottom by means of 8 self-tapping screws. The entire system is mounted in the lower case-half, with the top containing only the keyboard assembly and the LED indicator lights. This allows the machine to operate for testing purposes while partially disassembled. Also like previous machines, the entire system (sans Microdrives) is on one large double-sided glass-epoxy circuit board. The Microdrives are separate assemblies, with their own small circuit boards as an integral part of their construction. Since it's unlikely that you'd be servicing these on a component basis, their further disassembly won't be covered here.

QL disassembly can be broken down into three levels, or "phases". Phase 1 is a partial disassembly to access the main computer board. Phase 2 is a more complete

disassembly, involving the removal of the Microdrives and the main board (necessary only if you need access to the non-component side of the board.). Phase 3 is keyboard removal, which will only be necessary if you replace the membrane keyboard pad or keys. Both of the projects in this issue require only Phase 1 disassembly, but you might be inclined to do Phase 2 also, just for the experience.

PHASE 1 DISASSEMBLY

1: Remove the four short screws at the front of the machine, and the four long screws at the rear. There are two medium-length screws under the Microdrives; these only support the Microdrives, so you don't need to remove them for Phase 1.

2: Set the machine right-side-up, lift up the top case-half, and GENTLY disconnect the keyboard tails from their sockets. This is the weakest part of the machine's mechanics, and the one ZX feature I wish they HADN'T carried over to the QL.

3: Disconnect the LED wires from their socket. The socket is a type you may not have seen before; DON'T try to simply pull the wires out. Instead, grasp the black plastic portion of the socket and pull it upwards. This will unlock the wires, and they will all fall out. (Don't worry about what wire went where; I'll cover that in the section on re-assembly.)

4: The top case-half will now be free, and can be set aside.

Your machine may or may not have little fibre washers glued to the top of the mounting studs on the Microdrives. These studs aren't used in the QL, so Sinclair uses these little shims to take up any slack that would cause rattles, etc. Be aware that they're there, as they are quite easily knocked off.

THE GRAND TOUR

Well, look at all that stuff. Right off, you might notice the thoroughness of the shielding on this machine. The top case-half has a metal plate affixed with conductive paint. which contacts a spring-strap on the modulator case. This prevents the conductive inner coating from wearing away from repeated disassembly. The keyboard back-plane is similarly grounded to the conductive coating. Even the expansion-board cover is grounded with a spring-strap, making the machine an almost perfect "Faraday cage". The English QL, by the way, is not nearly as well shielded; presumably this is because European TV (UHF) is much less prone to interference.

Another difference is that the keyboard back-plane on the American version is made of Cadmium-plated steel instead of aluminum, making the overall computer significantly heavier.

All the way to the left, right next to the expansion connector, is the 68008 CPU. Having it close to the expansion connector minimizes lead length, and problems that could result from excessive trace lengths. The ground terminals are bridged with a solid piece of wire, and a small disk capacitor bypasses the V+ lead. These "tack-ons", absent on the British version, are directly soldered to the CPU pins. This is something I might be inclined to do, but I wouldn't have expected such constructions from a major computer manufacturer.

Right next to the CPU is the first of the three custom chips. If you look at the part number, you'll see that this one is "ZX8301". Remember rumors back in 1983 about a "ZX83"? Well, the QL is it. The ZX8301 chip takes care of TV picture generation, system clocking and address decoding, DRAM refreshing and controlling the bus.

Another custom chip is "ZX8302" (near the center of the board). This one controls the operation of all peripheral devices, including the Microdrives, net, real-time clock, and anything else you have connected.

Finally, there's "ZX83V0.7" (near the Microdrives). This is an Intel 8049 custom 8-bit microprocessor, with 2K of on-chip ROM and 128 bytes of RAM. Sinclair terms this the "Intelligent Peripheral Controller", (IPC) as it is a completely self-sufficient computer in itself. It works with ZX8302 to handle all I/O operations, including the keyboard, speaker, and RS232 ports.

Near the front of the board is the memory array, consisting of 16 4164A's (1 bit x 64K). Affixed with silicone cement to the left end of the array is a little tack-on board consisting of a high-speed CMOS hex inverter (only one gate used) and a couple resistors. Its function is a mystery at present, and the hardware manual offers no explanation. This, too, is absent on the British machine.

Between ZX8301 and ZX8302 are the two ROMs, one 16K and one 32K. By the time ROMs were commissioned, Sinclair had apparently changed the name from "ZX83" to "QL", as reflected by the ROM designations.

The expansion connector and the ROM socket are both supported only by their legs, but the joystick and serial port connectors

are firmly bolted to a steel plate at the rear of the machine; another departure from the British version. Next to these is the TV modulator. In front of the modulator is the RGB video chip (MC1377). Another chip, MC1489, is used for NTSC composite video; this is the chip whose output we'll intercept to allow use with a colour composite monitor.

Various buffers, logic chips, transistors, diodes and regulators round out the semiconductor complement. Separate crystals are used to clock the main CPU (via ZX8301), the IPC, the MC1377 video chip, and the real-time clock.

The DIN monitor connector is of a type which prevents "tapping in" from the top of the board. Doing anything with this (such as inverting the RGB sync line internally) would therefore require Phase 2 disassembly.

At the front-right, of course, are the Microdrives. Their controller cards are bolted to the rear of the plastic "chassis". Note that the controller chips are Ferranti ULA's (that's right, the same people who made the logic chip for the ZX81). In passing, I'll point out a few features that contribute to the Sinclairs drive's high reliability over similar schemes.

First, the drive is from the side rather than the front, minimizing tape damage from excessive insertion force. Secondly, the capstan is made of rubber instead of metal, minimizing the possibility of grit putting dents in the tape. They are also quite large, reducing the possibility of damage from having the tape stopped for an extended time. The heads are not adjustable, being soldered directly to the circuit board, This reduces the possibility of misalignment and resulting bad loads.

Behind the Microdrives, is a big heat-sink for the 7805 regulator. This regulator is socketed, presumably for ease in assembly. Behind the heat-sink is another conspicuous add-on, a big toroidal inductor. This serves exactly the same purpose as the two little coils on the ZX81, which is to prevent RF interference from travelling back out through the power supply line. However, it also causes the same regulator bug that plagues the ZX81! (See SyncWare News #3:4.) Come on, Sinclair, read the 7800 -series spec sheets!

DEBUG YOUR REGULATOR

The importance of this little modification cannot be overstressed. If you don't do it, you're playing Russian Roulette. Even if your machine seems to work fine, it can develop strange and unpredictable problems when you expand it, or line voltage changes, or virtually anything else. A 3-terminal regulator is very unstable if there is an inductor in its input line; the way to correct this instability is to install a small capacitor at its input.

Get yourself a .1uF capacitor rated 16 volts or better. Disc ceramic is OK, but I prefer tantalum. Clip the leads off to about 1 cm., and stick them into the regulator socket along side the regulator legs. One terminal goes to the center leg, the other to the leg on the right (as viewed from the front). If you're using a tantalum cap, observe polarity; the "minus" lead goes to the center leg.

PHASE 2 DISASSEMBLY

When continuing your tear-down, be alert to all washers. shims, etc. that appear as you progress. As mentioned earlier, Sinclair employs fibre washers on an as-needed basis to take up slack. Others are used to prevent shorts or to provide pressure relief. Ideally, you should use an organizing tray to keep track of the small parts as you take your machine apart.

1: Follow steps 1-4 in "Phase 1 disassembly", above.

2: Remove the two medium-length screws that support the Microdrives from the bottom.

3: Remove the four screws (two per unit) that support the Microdrives from the top. These are the round-head, NOT the flat-head screws. Also note that they are not of the same length. The shorter one is the one in the front left corner, the longer one is about 1 cm. to the right of the head.

4: Carefully unplug the ribbon cables that connect the Microdrives to the main board. The Microdrives will then lift out; set them aside.

5: Remove the cover on the Microdrive expansion connector. The board won't come out if you don't do this. Note also that the single "prong" on the cover must be on top when you re-install it; it won't fit properly the other way.

6: Disconnect the speaker wires.

7: Remove the two screws that mount the main board. One is just to the left of the CPU, the other is just behind and slightly to the right of the speaker.

8: The board is now free to come out. However, there are two snags; the first is the grounding strap for the ROM cartridge port; note its original position and gently bend it back. The second is the reset switch; you have to pull off the black knob (it's

just a press-fit on the switch shaft). Fully depress the switch shaft as you ease the board out; even then, it will just barely clear.

PHASE 3 DISASSEMBLY

This will only be necessary if you damage the keyboard tails, requiring replacement of the membrane keyboard element. Cut the grounding foil on one side only, and remove the 7 screws. Fold the base-plate up, being careful not to tear the other grounding foil. The keyboard membrane can now be replaced.

RE-ASSEMBLY

Re-assembly is exactly the reverse of the assembly steps. Some points to watch out for:

* Be VERY careful when re-connecting the Microdrives. Two needle-nose pliers can be used to advantage to re-insert the ribbon cables evenly.

* Be VERY VERY careful when re-connecting the keyboard tails. These are VERY EASILY damaged. Use a firm pressure, but don't let them kink.

* When re-connecting the LED wires, the colors of the wires (starting at the rear of the connector) are: Red, Black, White, Black, Green, Black. The exact locations of the three black wires is unimportant.

* When re-installing the Microdrives, be sure that the speaker wires aren't pinched.

*Don't over-torque the screws! Tighten them only until they are well-seated. Overtorquing will strip the threads in the studs.

* There is a crystal folded over the MC1489 chip. It is possible for its grounding wire to touch a trace on the keyboard tail, resulting in a crash. To prevent this, put a piece of tape over the crystal.

Happy Hacking

QUANTUM LEVELS...

is a bi-monthly publication of the SyncWare Group for owners of QL computers.

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If you have made any discoveries on your computer and would like to share them with your compatriots, please submit hardcopy along with a well labeled media as microdrive cartridges, 5 1/4 or 3 1/2 inch disks. Articles are reimbursed on publication, If you would like to make regular submissions, send us your ideas.

PACKET TO FIDO
K5XY

Packet Bulletin Board Stations are so much like telephone line stations that it was just a matter of time before they were linked. There are now several linked around the country and our Sinclair FIDO BBS is one of these.

N5ICC, Jim, and I were testing the link the other day. Jim has put a lot of work into the connection which uses N5ICC, his packet station.

The commands are still undergoing change, but for now when a packet station connects N5ICC one sends a G to open the gateway feature of the N5ICC packet PBBS. One then sends U to select the unconnected mode of transmission on the part of N5ICC. A * then connects to the FIDO BBS and the resulting exchanges are just like the telephone exchanges. To release FIDO and return to the Gateway, one sends ^W (Control W). A B will then disconnect you from the packet PBBS.

When I first saw the commands, I started to worry a bit because the T/S 1500 I was using does not have all the commands that other people use. But, because I was using the Comlink I adapter, I should not have worried. The adapter provides all the control commands with a shift 7 key so for ^W all I had to do was send shift 7 W. Of course * is a shifted B but I did have to look a bit for it because I do not send it

(continued on page 8)

(Refer to QL circuit board layout)

QL IC PARTS LIST

Number	Part #	Manufacturer
IC 1 to 16	4164 (equiv)	Various (RAM)
IC 17	74HC04	(Spider board)
IC 18	MC68008	Motorola
IC 19,20	74LS257	Various
IC 21	74LS245	Various
IC 22	ZX8301	Plessy/Sinclair
IC 23	ZX8302	NCR/Sinclair
IC 24	8049	NEC
IC 25	1488	NEC
IC 26	1489A	NEC
IC 27	74LS03	not used
IC 28	MC1377P	Motorola
IC 29 (MDV1)	2G007	Ferranti
IC 30 (MDV2)	2G007	Ferranti
IC 31 (MDV1)	78M05	various
IC 32 (MDV2)	78M05	various
IC 33	32K ROM JSU	
IC 34	16K ROM (23128)	
IC 35		not used
IC 36	79L12	various
IC 37	78L12	various
IC 38	HAL16L8	Sinclair

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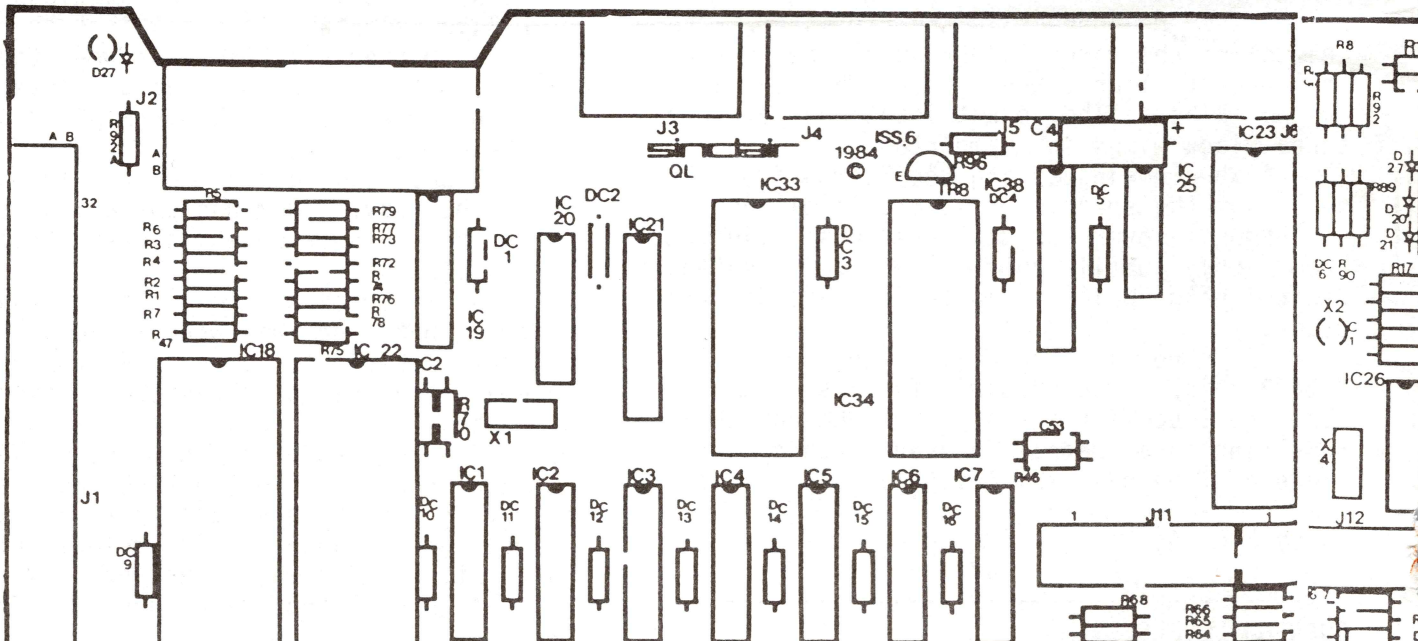

QL CIRCUIT BOARD (issue 6) COMPONENT LAYOUT

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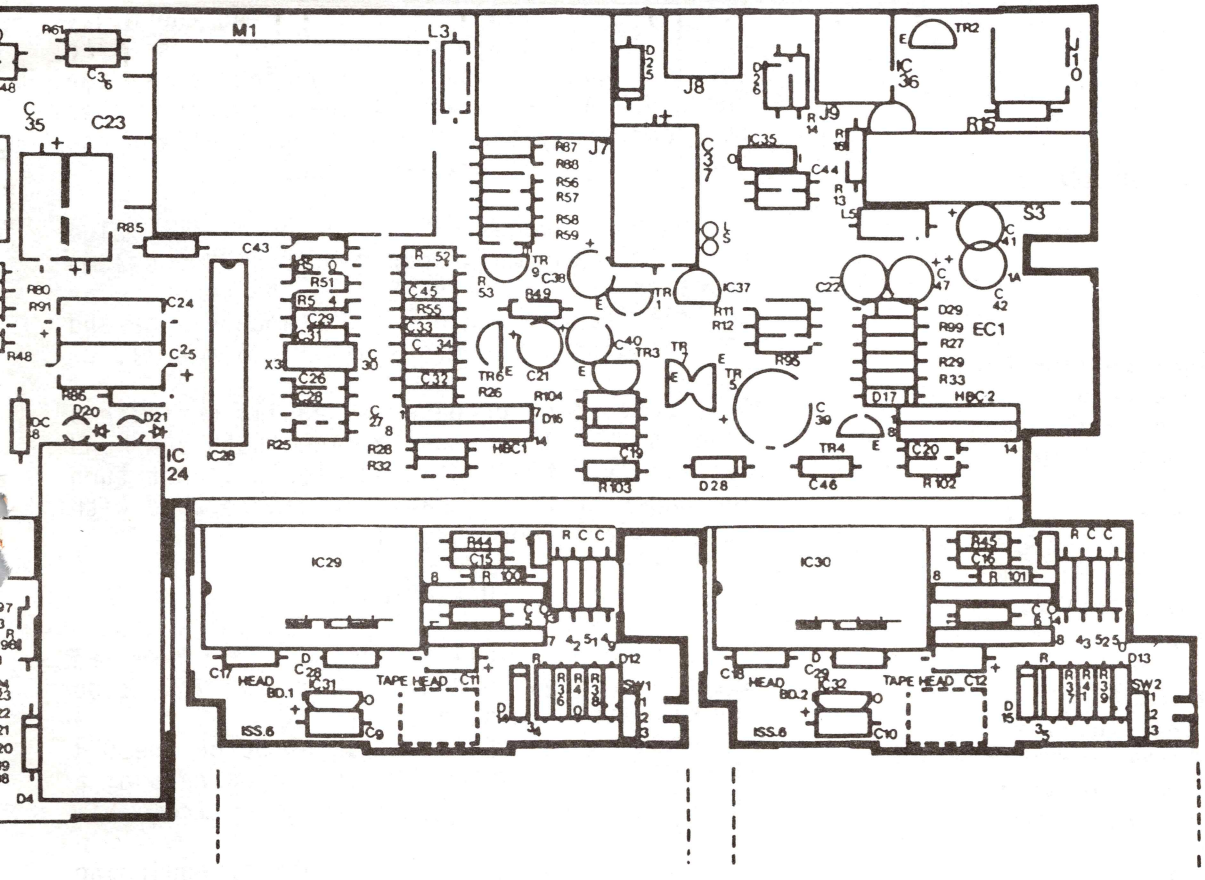

MDV1 MDV2

often.

In any case, I was able to use my T/S 1500 and TNC to easily access the FIDO board by radio and look at our QZX files in file area 18.

Computer Hyper-graphics
ZX-81/TS-1000
By Clem Wehner, K5KGM

Here's a simple program that is sure to delight you while you wait for your rig to warm up or the band to open. It would make a great opening screen display for a ham radio program.

It produces the most unusual screen graphics you've ever seen on your ZX/TS. You create your own super graphics and then display them singly or in a high speed continuous demonstration. For you programmers, the program alters the I register which contains the high order address of the graphics table.

```
1 REM 12345
2 SLOW
3 POKE 16514,62
4 POKE 16515,30
5 POKE 16516,237
6 POKE 16517,71
7 POKE 16518,201
10 FOR I = 0 TO 30
20 POKE 16515,I
30 RAND USR 16514
40 FOR J = 1 TO 32
50 PRINT "THIS IS DEMONSTRATION" ;
60 NEXT J
70 CLS
80 NEXT I
```

NOTES:

1. Try different messages in line 50. Do NOT exceed 21 characters.
2. To view one of the pictures, press BREAK. To restart, press CONT, then ENTER.
3. Try deleting lines 40 through 70, then enter RUN for a high speed demo.
4. Try different loops at line 10. But then you must add:
   ```
   90 POKE 16515,30
   100 RAND USR 16514
   ```
5. If while experimenting, you stop the program, you will notice that the program lines are unreadable. To restore things to normal, type:
   ```
   EDIT, (then enter)
   POKE 16515,30
   RAND USR 16514
   ```

This amazing demonstration will only work on the ZX-81/TS-1000 because of the addressing of the graphics table. When friends brag about their fancy computer's graphics, challenge them to produce graphics like these. They won't snicker any more!

BITS AND BYTES

93. Define the following function if you want to add the ability to get the free memory from the QL at any time.

```
100 DEFine Function FREE_MEMORY
110 RETurn PEEK_L(103856)-PEEK_L(163852)
120 END DEFine FREE_MEMORY
```

after the above is entered into your program you can get the amount of free memory left at any time by using

```
PRINT FREE_MEMORY
```

94. In the QL, the pinch roller in the microdrives has a tendency to rise upwards after a few months of use. A tiny drop of super glue will cure the problem.

95. K7FG says the in checking-out my newly acquired CWSS receive program of Cliff Nunnery, NU4V, I found that placing the Winky board of Russell Electronics in series with the CW audio input greatly increases the bandwidth and accuracy of the display. Use the same Winky board connections that you use for loading programs from tape.

96. K9PL suggests a good source for blue printing thermal paper for 32 column printers. He uses 8.5 inch paper for Hewlett-Packard which is 8.5 inches wide and 100 feet long. It costs him $3.95 a roll.

97. Roll computer paper is easily cut with a band saw. If you use a fine tooth saw and cut slowly, the heat generated will not turn the paper brown. A hack saw can be used with only a little more trouble.

QZX FRIENDS

KA8RNY -- Bill rejoined to get an article on how to convert his new T/S 1500 for use with a monitor.

WD4JKH -- David called us up on the QZX bulletin board system to get the address of a supplier. We were glad to hear from him again.

WOON -- Roy is thinking about equipping his T/S 2068 to run the spectrum programs. He is already using the NU4V cwss program

with a ZX-81 and has just gotten the NRAP RTTY program.

W3NIJ -- Cecil was a very active user of Sinclair computers. He owned a ZX80, several ZX81's, an T/S 1000, a T/S 1500, and a T/S 2068. Unfortunately he became a silent key before he could become familiar with the QL. His XYL sent a modest donation to QZX in his name, which will go to continuing this journal which he enjoyed.

W1SPP -- Ed has been in the hospital for quite some time. But he is now out and back to his computers and to QZX for another year.

W9CQD -- Russell renewed. He has been with us since 1982.

WA2NDJ -- Syd says he still loves the T/S 2068.

KA5YZG -- David sent us a reminder that Aerco has disk drives for all the Sinclair computers.

PUBLISHER'S NOTES

We still have a fairly complete supply of back issues. We are sold out of about two issues from the last two years and have scattered earlier issues. These issues will be sent post paid to any subscriber at $1.00 for each issue. Unfortunately, we do not have an index, so the best use of these issues is to complete or extend you collection or to pick up programs for our computers.

As a result of stories in various magazines, we have been able to pick up some needed new members. These stories featured our FIDO BBS known as Net 15 Mode 6. You can send FIDO messages via your local FIDO BBS to ALEX BURR (at 15/6) or call our local FIDO BBS direct at (505) 522-7081. The Sinclair file area is number 18. There you will find files of old articles and of articles yet to be published.

It would be quite helpful if our readers would let any club newsletters, hamfests, or other clubs they are in contact with know of our existence and of our support for the Sinclair computers.

Quantum Levels is a quarterly technical magazine for the QL published by Thomas B. Woods (see address in ad in this issue). It has good articles and the following interesting astute observations.

Q fucius say ...

... Man who buy only one QL for whole family have Fight Simulator!

Q fucius also say ...

... Man who drop QL in asphalt have Atari Computer!

UNCLASSIFIED ADS

WANTED: UNCLASSIFIED ADS for publication in QZX. Cost is 1 cent for each keystroke (characters, blanks, etc.). Payment must be included with order. This is an excellent way to sell your program or unwanted equipment, ask for help, or find a specific program. Send your ad with payment to QZX, 2025 O'Donnell, Las Cruces, NM 88001.

COMPUTER FEST: THE 2ND ANNUAL MIDWEST TIMEX-SINCLAIR COMPUTER FEST! MAY 2ND and 3RD, 1987 at Indianapolis, IN.

It will be held at the Holiday Inn North, just off I-465 and Highway 421. The mailing address is Holiday Inn North, 3850 DePauw Blvd., Indianapolis, IN 46268. Special rates of $52 per night per room, no extra charge for more people or double beds. To get this rate mention the Fest when you call to make your reservations. Call 1-800-HOLIDAY.

The show will have all of your favorite Timex-Sinclair vendors, User Groups, Magazines, lectures, seminars. This is your chance to see all of the hardware and software before you buy it. The price of all of this is only $4 if you preregister before 3-30-87 and $6 after this date for individuals, and $7 for family registration up till 3-30-87 and $9 after that date. Send checks to Midwest Timex-Sinclair Computer Fest, 513 East Main, Peru, IN 46970. For information or confirmation of registration send SASE to above address.

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TELEPHONE BBS TABLE

					Access by PC Pursuit	Accepts 'Stacked' Commands	300 BPS	1200 BPS	2400 BPS	No. of Message Bases	E-Mail	2068 Downloads	1000 Downloads	Total System Capacity	Total T/S Downloads	Total CP/M Downloads	
AVERAGE REMOTE	(213)325-0213	8,1,N	24Hrs		Y		Y	Y	N	1	Y	Y	Y	21 MB	1 MB	MB	Los Angeles, California
BILL'S OBSESSION	(404)377-2550	8,1,N	90%		Y	Y	Y	Y		2	Y	Y	N	22 MB	300 KB	2 MB	Atlanta, Georgia
COMPUSERVE	(Local No.)	7,1,0	24Hrs			N	Y	Y	Y	2	Y	Y	Y			Y	Columbus, Ohio
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LOONEY BIN!	(619)390-9470	7,1,0	24Hrs		N	N	Y	N	N	1	N			562 KB	0	0	San Diego, California
MCI MAIL	(Telenet)	8,1,N	24Hrs			N	Y	Y	Y	0	Y	N	N		0	0	Wash,D.C.
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STARTEXT	(817)877-1041	8,1,N	24Hrs			N	Y	Y	N	0	Y	Y	N				Ft.Worth, Texas
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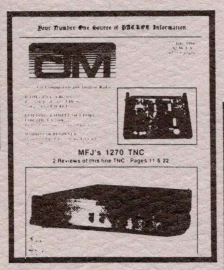

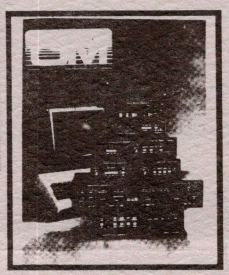

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